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# A novel multi-jet polishing process and tool for high-efficiency polishing

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## Abstract

Traditional fluid jet polishing (FJP) is limited by its low material removal rate and its applicability to medium-large size surfaces. This paper presents a novel multi-jet polishing (MJP) process and tools based on FJP which can implement high-efficiency polishing on large-scale surfaces or lens array surfaces. The MJP makes use of a purposely designed nozzle which possesses many regularly distributed holes, whose number can be a few to several hundred. Moreover, each hole can spray out a high-energy fluid jet leading to a dramatic increase of material removal. Its feasibility is firstly analyzed through a Computational Fluid Dynamics (CFD) simulation. Hence, its surface generation mechanisms in the integrated polishing mode and discrete polishing mode are studied. After that, a series of polishing experiments on different materials are conducted to validate its polishing performance as compared to single jet polishing (SJP). The experimental results show that the MJP tool can realize a much higher material removal rate, together with compatible surface roughness to SJP. Hence, the MJP tool has the potential to implement high-efficiency polishing on medium-large size surfaces and lens array surfaces.

**Keywords:** multi-jet polishing, surface generation, computational fluid dynamics, lens array, ultra-precision machining

## 1. Introduction

With the increasing need for ultra-precision optical components, many sub-aperture polishing methods have been proposed to enhance the polishing efficiency or surface accuracy in recent years. Fluid jet polishing (FJP), proposed by Faehnle et al. [1,2], is one of the promising polishing methods which depends on the pressured mixing of water and abrasive fluid to interact with the workpiece so as to generate material removal. Different from traditional abrasive jet cutting or milling [3-5], the working pressure is relatively low, between 4 bars and 20 bars [6].

Compared with other polishing methods, FJP is a non-contact processing method and has many advantages [7-9], such as high machining accuracy, suitability for polishing various complex surfaces (especially steep, concave aspheric surfaces), undergoes no tool wear and causes no temperature increase of the workpiece during polishing, etc. It has been widely used in polishing optical glass and moulds [8,10], ceramics [11], etc.